there is a carefully selected bibliography at the end of each chapter, and that the references are punctiliously accurate.

The third part of the book gives a systematic account of the whole phylum of vertebrates, and takes due notice of the extinct forms. There are many interesting detailed expressions of the author's judgment, *e.g.* his treatment of the Ratitæ as a heterogeneous group derivable from at least three stocks, or his reuniting of Marsupials with Eutheria; but the outstanding feature in this section is to be found in the numerous carefully drawn up schemata showing distribution in time and probable affinities. There are twenty of these, condensing much reflection.

In the concluding section of his book, Prof. Vialleton deals analytically with the problem of the evolution of vertebrates. He discusses the origin of organs, and makes much of Kleinenberg's theory of substitution; he distinguishes between well-established genetic series and morphological series (so often mixed up together, *e.g.* in connection with the evolution of Equidæ); he recognises the importance of paying more attention to the phenomena of convergence; he gives an admirable discussion of correlation and of vestigial organs. Passing to the actual data bearing on the phylogeny of vertebrates, he marshals the palæontological facts in a masterly way, and discusses such points as the successive appearance of classes, the occurrence of generalised types and transitional types, the absence of the latter at phyletic bifurcations, the extinction of types, and the indubitable progress from age to age. Turning to embryological data we find an admirable critical discussion of the recapitulation doctrine, of which there is little left when the author has done. We cannot help feeling, however, that there is sure to be a rebound in a few years to some subtler rehabilitation of Haeckel's famous biogenetic law. The author believes in a good deal of polyphyletism, and he confesses himself a mutationist: *transformist* theories do not please him: "C'est l'évolution avec ses brusqueries et ses divergences qui constitue la réalité."

THE PRINCIPLE OF RELATIVITY.

Das Relativitätsprinzip. By Dr. M. Laue. Pp. x+208. (Braunschweig: F. Vieweg und Sohn, 1911.) Price 6.50 marks.

IT is almost impossible nowadays to glance through a journal containing original papers in physics without coming across something relating to the Principle of Relativity. This principle is an extension of that Newtonian relativity which enables us to treat machines on a moving earth as if they were at rest. The new extension covers the phenomena of optics, heat, and electromagnetism. It is sometimes called the electromagnetic principle of relativity, but as it contains also a mechanical principle it has now become usual to term it simply the Principle of Relativity. It asserts that physical phenomena generally do not depend upon rectilinear uniform translation through space; that, for instance, the optical isotropy of space is not affected by motion through it; that the velocity of light is the same in all directions and independent of displacement; and that it is therefore impossible to discover, say, the earth's motion of translation by any optical, electrical, or mechanical device. In fact, it is based upon the negative result of the Michelson-Morley experiment, and all other attempts to discover "æther-drift."

Einstein, who founded the modern relativity theory in 1905, based his arguments upon the impossibility of establishing an absolute time-scale, either as regards rate or as regards epoch, so long as the utmost limit of rapidity of signalling is imposed by the finite velocity of light. He showed how this limitation affects all measurements of length and time whenever the relative velocity dealt with approaches the velocity of light. The clocks in a moving system, synchronised by light signals, necessarily have a slower rate than those in a system at rest, in the ratio $\sqrt{1-\frac{v^2}{c^2}} : 1$, where v is the relative velocity and c the velocity of light, and this applies whichever of two systems is regarded as being at rest. There is, in fact, no "absolute" time-scale.

Many conclusions from this principle appear far-fetched, even fantastic. Thus, not only electrons, but all matter possesses an infinite "mass" when moving with the velocity of light; mass is identical with latent energy; two particles projected in opposite directions with the velocity of light have a "relative" velocity which simply equals the velocity of light, and so on. In spite of such apparent absurdities, the Principle of Relativity has made what is no less than a triumphal march through the world's physical publications.

Dr. Laue's work comes, therefore, as a welcome contribution to what has become a matter of very living interest. He goes fully into the negative results of Michelson, Trouton, Brace, Rayleigh, and others, the positive results of Wilson, Rowland, Eichenwald, Lebedew, Poynting (misspelt "Pointing"), and Fizeau, and the theoretical work of Lorentz, Einstein, and Minkowski. He shows that there is no physical evidence against the principle, and that it has the advantage over other systems of accounting for the absence of æther-drift. In the analytical work, a vector algebra on the basis of Heaviside's notation is used, but it is made, after Minkowski's example, four-dimensional. A brief summary of operations with these "world-vectors" is of great assistance to the reader. E. E. F.

OUR BOOK SHELF.

The Principles of Electric Wave Telegraphy and Telephony. By Prof. J. A. Fleming, F.R.S. Second edition (revised and extended). Pp. xx+906. (London: Longmans, Green and Co., 1910.) Price 28*s.* net.

WHEN reviewing the first edition of Prof. Fleming's book five years ago we pointed out that it filled to perfection the want for a thorough and exhaustive treatise on the subject of wireless telegraphy, and was sure of a warm welcome on that account. Since then the volume has been twice reprinted, and now there is issued a new edition largely rewritten and considerably improved. The rapid pro-

gress in electric wave signalling is indicated even in the title, which is now so worded as to cover the subject of Hertzian telephony, at the time of the first edition so much in its infancy as not to be worthy of inclusion. To this subject Prof. Fleming now devotes a short final chapter, in which he reviews briefly the special difficulties in transmission and summarises the present position. (In the last paragraph, by an obvious oversight, telegraphy is written in place of telephony.)

Much of the volume has had to be revised on account of the progress which has been made in all directions. The author has acted wisely in curtailing the historical portions and devoting himself mainly to the explanation of the scientific principles on which the art of wireless telegraphy is based, and on which the numerous instruments now used are founded. The purely historical side of wireless telegraphy is now more or less a matter of the past: it has entered into a period of development which if less sensational is of more benefit to mankind. From the more or less crude empirical art of ten years ago wireless telegraphy is now firmly based on a solid scientific foundation, exact methods of measurement have been developed, and steady progress, not less rapid because of its steadiness, is possible. Prof. Fleming's book still deserves to rank as the best existing treatise on the subject, at any rate in the English language, and if the same industry is shown in the future in keeping it up to date it should continue for long to hold this premier position. M. S.

Die Anwendung der stereographischen Projektion bei kristallographischen Untersuchungen. By Prof. H. E. Boeke. Pp. viii+58+plate. (Berlin: Gebrüder Borntraeger, 1911.) Price 2.60 marks.

THE stereographic is the form of plane projection of the sphere ordinarily in use in crystallographic work, and during recent years it has come much into vogue, not merely for showing the zonal relations subsisting between the poles corresponding to the faces of a crystal, but also as a means of checking the accuracy of the calculations involved in the goniometric measurement of a crystal. Accordingly, various methods by means of nets or protractors have been devised to facilitate the use of the projection, many of which have scarcely yet found their way into the text-books. Penfield provided for English readers in a series of brilliant papers that appeared in *The American Journal of Science* a clear and concise account of the best and most practicable methods, and, moreover, designed various diagrams to aid the student in plotting the positions of the poles.

In the present volume Prof. Boeke aims at providing similar privileges for German readers. He gives a clear account of the properties of the projection, and discusses at some length its use as an aid in computation in the case of the several kinds of systems of crystalline symmetry, both geometrical and graphical proofs being given of the fundamental propositions. The application of the projection to crystal drawing and the determination of the optical characters are also explained. A pocket in the cover contains one of Prof. Wulff's stereographic nets, which are graduated in distance and azimuth referred to a pole in the equatorial zone for every other degree, the size of the sphere being the same as that selected by Penfield, viz. 14 cm.

The book is one that may be commended for the use of students of crystallography, but it might advantageously have included an adequate description of the properties and use of the gnomonic projection which at present is merely alluded to in a brief paragraph, even though some slight alteration of the title would have been involved.

Quaternions as the Result of Algebraic Operations. By Dr. A. L. Baker. Pp. ix+92. (London: Constable and Co., Ltd., 1911.) Price 6*s.* net.

IN this book the author establishes the principles of quaternions by the use of the six operations—addition, subtraction, multiplication, division, reversion, and mean reversion. By the introduction of reversion, we pass from arithmetic to algebra. Complex functions depend on the recognition of mean reversion, the operands still being scalars; and when the operands are scalars and vectors, the method becomes generalised into quaternions.

The key of the argument is the conception of *mean reversion*, that operation which twice repeated reverses the quantity operated on. There is nothing new in this, but Dr. Baker applies the conception in an unusual way to the representation of a scalar as a sphere in space, which, as possessing perfect symmetry and therefore devoid of direction in space, is the only available ideographic symbol for a scalar. He finds that a mean reversed scalar is represented in all its properties by a directed magnitude in space, that is, by a vector. The algebraic representation of mean reversal is, of course, $\sqrt{-1}$, leading to the usual Argand diagram; and the same idea enters into the constitution of any vector. The argument that $ii=-1$ may be accepted as sufficiently sound; but it may be doubted if the rule for the product of perpendicular vectors, viz. $ij=k$, &c., can be rigorously deduced on the assumption that the operation of a vector α upon a perpendicular vector β must be the same in kind, but as far removed in detail from that which would have been used had β been parallel to α. We certainly prefer Hamilton's own somewhat metaphysical argument.

It is clear that Dr. Baker has no regard for the views of those self-styled purists who deny that a vector can have versor properties. Having established the well-known i, j, k rules, he develops in a satisfactory manner the important properties of quaternions, and ends his discussion by a useful account of the linear vector function. Students new to the method will probably find the argument in the earlier chapters difficult to follow; thereafter all is plain sailing.

C. G. K.

Lessons on Soil. By Dr. E. J. Russell. Pp. xv+132. (Cambridge University Press, 1911.) Price 1*s.* 6*d.*

A COURSE of lessons on soil provides an essential sequence to the formation of school gardens if it is desired to make the best use of the latter. Teachers contemplating such a course are strongly recommended to consult this excellent primer, in which Dr. Russell presents a series of lessons evolved from practical classes conducted for children in the higher standards at an elementary school and in an intermediate form at a secondary school. The earlier chapters contain simple experiments for observing the properties of clay, sand, and other soil constituents; pot cultures are introduced to compare the food value of soil and subsoil, as also the action of water in soils; methods are described for detecting the presence of soil organisms and for demonstrating the advantages of hoeing. Finally, the practical bearing of the lessons, which it should be noted are confined to soil physics, is indicated, not only with reference to agriculture, but also as they serve to explain the aspects of the countryside and other natural features such as the connection between stream, ford, and village. The primer is not only practical and informative, but is designed to arouse the inquiring instinct. It is the first volume of a new series contemplated by the Syndics of the Cambridge University Press.